



SEQUENCE LISTING

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Castle, John C  
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Thr Asp Asn Asn Val Ile Tyr Gln Val Asp Gly Ser Lys Ser Phe Asn  
35 40 45

Phe Asp Arg Val Phe His Gly Asn Glu Thr Thr Lys Asn Val Tyr Glu  
50 55 60

Glu Ile Ala Ala Pro Ile Ile Asp Ser Ala Ile Gln Gly Tyr Asn Gly  
65 70 75 80

Thr	Ile	Phe	Ala	Tyr	Gly	Gln	Thr	Ala	Ser	Gly	Lys	Thr	Tyr	Thr	Met	85	90	95	
Met	Gly	Ser	Glu	Asp	His	Leu	Gly	Val	Ile	Pro	Arg	Ala	Ile	His	Asp	100	105	110	
Ile	Phe	Gln	Lys	Ile	Lys	Lys	Phe	Pro	Asp	Arg	Glu	Phe	Leu	Leu	Arg	115	120	125	
Val	Ser	Tyr	Met	Glu	Ile	Tyr	Asn	Glu	Thr	Ile	Thr	Asp	Leu	Leu	Cys	130	135	140	
Gly	Thr	Gln	Lys	Met	Lys	Pro	Leu	Ile	Ile	Arg	Glu	Asp	Val	Asn	Arg	145	150	155	160
Asn	Val	Tyr	Val	Ala	Asp	Leu	Thr	Glu	Glu	Val	Val	Tyr	Thr	Ser	Glu	165	170	175	
Met	Ala	Leu	Lys	Trp	Ile	Thr	Lys	Gly	Glu	Lys	Ser	Arg	His	Tyr	Gly	180	185	190	
Glu	Thr	Lys	Met	Asn	Gln	Arg	Ser	Ser	Arg	Ser	His	Thr	Ile	Phe	Arg	195	200	205	
Met	Ile	Leu	Glu	Ser	Arg	Glu	Lys	Gly	Glu	Pro	Ser	Asn	Cys	Glu	Gly	210	215	220	
Ser	Val	Lys	Val	Ser	His	Leu	Asn	Leu	Val	Asp	Leu	Ala	Gly	Ser	Glu	225	230	235	240
Arg	Ala	Ala	Gln	Thr	Gly	Ala	Ala	Gly	Val	Arg	Leu	Lys	Glu	Gly	Cys	245	250	255	
Asn	Ile	Asn	Arg	Ser	Leu	Phe	Ile	Leu	Gly	Gln	Val	Ile	Lys	Lys	Leu	260	265	270	
Ser	Asp	Gly	Gln	Val	Gly	Gly	Phe	Ile	Asn	Tyr	Arg	Asp	Ser	Lys	Leu	275	280	285	
Thr	Arg	Ile	Leu	Gln	Asn	Ser	Leu	Gly	Gly	Asn	Ala	Lys	Thr	Arg	Ile	290	295	300	



Ile Cys Thr Ile Thr Pro Val Ser Phe Asp Glu Thr Leu Thr Ala Leu  
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Gln Phe Ala Ser Thr Ala Lys Tyr Met Lys Asn Thr Pro Tyr Val Asn  
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Leu Leu Gln Lys Val Gln Asn Glu Lys Ile Glu Asn Leu Thr Arg Met  
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Leu Val Thr Ser Ser Ser Leu Thr Leu Gln Gln Glu Leu Lys Ala Lys  
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Arg Lys Arg Arg Val Thr Trp Cys Leu Gly Lys Ile Asn Lys Met Lys  
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Asn Ser Asn Tyr Ala Asp Gln Phe Asn Ile Pro Thr Asn Ile Thr Thr  
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Lys Thr His Lys Leu Ser Ile Asn Leu Leu Arg Glu Ile Asp Glu Ser  
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Val Cys Ser Glu Ser Asp Val Phe Ser Asn Thr Leu Asp Thr Leu Ser  
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Glu Ile Glu Trp Asn Pro Ala Thr Lys Leu Leu Asn Gln Glu Asn Ile  
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Glu Ser Glu Leu Asn Ser Leu Arg Ala Asp Tyr Asp Asn Leu Val Leu  
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Asp Tyr Glu Gln Leu Arg Thr Glu Lys Glu Glu Met Glu Leu Lys Leu  
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Glu Lys Glu Asp Gln Ile Lys Lys Leu Gln Glu Tyr Ile Asp Ser Gln  
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Lys Leu Glu Asn Ile Lys Met Asp Leu Ser Tyr Ser Leu Glu Ser Ile  
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Glu Asn Asp Ile Gln Leu Tyr Gln Ser Gln Leu Glu Ala Lys Lys Lys  
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Cys Asn Leu Glu Leu Glu Gly Lys Ile Thr Asp Leu Gln Lys Glu Leu  
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Leu Ser Glu Leu Lys Ser Leu Pro Ser Glu Val Glu Arg Leu Arg Lys  
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Glu Ile Gln Asp Lys Ser Glu Glu Leu His Ile Ile Thr Ser Glu Lys  
740 745 750

Asp Lys Leu Phe Ser Glu Val Val His Lys Glu Ser Arg Val Gln Gly  
755 760 765

Leu Leu Glu Glu Ile Gly Lys Thr Lys Asp Asp Leu Ala Thr Thr Gln  
770 775 780

Ser Asn Tyr Lys Ser Thr Asp Gln Glu Phe Gln Asn Phe Lys Thr Leu  
785 790 795 800

His Met Asp Phe Glu Gln Lys Tyr Lys Met Val Leu Glu Glu Asn Glu  
805 810 815

Arg Met Asn Gln Glu Ile Val Asn Leu Ser Lys Glu Ala Gln Lys Phe  
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Glu Leu Gln Glu Lys Thr Arg Glu Val Gln Glu Arg Leu Asn Glu Met  
850 855 860

Glu Gln Leu Lys Glu Gln Leu Glu Asn Arg Asp Ser Pro Leu Gln Thr  
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Val Glu Arg Glu Lys Thr Leu Ile Thr Glu Lys Leu Gln Gln Thr Leu  
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Glu Glu Val Lys Thr Leu Thr Gln Glu Lys Asp Asp Leu Lys Gln Leu  
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Gln Glu Ser Leu Gln Ile Glu Arg Asp Gln Leu Lys Ser Asp Ile His  
915 920 925

Asp Thr Val Asn Met Asn Ile Asp Thr Gln Glu Gln Leu Arg Asn Ala  
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Leu Glu Ser Leu Lys Gln His Gln Glu Thr Ile Asn Thr Leu Lys Ser  
945 950 955 960

Lys Ile Ser Glu Glu Val Ser Arg Asn Leu His Met Glu Glu Asn Thr  
965 970 975

Gly Glu Thr Lys Asp Glu Phe Gln Gln Lys Met Val Gly Ile Asp Lys  
980 985 990

Lys Gln Asp Leu Glu Ala Lys Asn Thr Gln Thr Leu Thr Ala Asp Val  
995 1000 1005

Lys Asp Asn Glu Ile Ile Glu Gln Gln Arg Lys Ile Phe Ser Leu  
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Ile Gln Glu Lys Asn Glu Leu Gln Gln Met Leu Glu Ser Val Ile  
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Ala Glu Lys Glu Gln Leu Lys Thr Asp Leu Lys Glu Asn Ile Glu  
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Met Thr Ile Glu Asn Gln Glu Glu Leu Arg Leu Leu Gly Asp Glu  
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Leu Lys Lys Gln Gln Glu Ile Val Ala Gln Glu Lys Asn His Ala  
1070 1075 1080

Ile Lys Lys Glu Gly Glu Leu Ser Arg Thr Cys Asp Arg Leu Ala  
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Glu Val Glu Glu Lys Leu Lys Glu Lys Ser Gln Gln Leu Gln Glu  
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Lys Gln Gln Gln Leu Leu Asn Val Gln Glu Glu Met Ser Glu Met  
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Gln Lys Lys Ile Asn Glu Ile Glu Asn Leu Lys Asn Glu Leu Lys  
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Asn Lys Glu Leu Thr Leu Glu His Met Glu Thr Glu Arg Leu Glu  
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Leu Ala Gln Lys Leu Asn Glu Asn Tyr Glu Glu Val Lys Ser Ile  
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Thr Lys Glu Arg Lys Val Leu Lys Glu Leu Gln Lys Ser Phe Glu  
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1220						1225					1230			
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1235						1240					1245			
Ser	His	Thr	Lys	Leu	Gln	Glu	Glu	Ile	Pro	Val	Leu	His	Glu	Glu
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Gln	Glu	Leu	Leu	Pro	Asn	Val	Lys	Lys	Val	Ser	Glu	Thr	Gln	Glu
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1370						1375					1380			
Phe	Lys	Pro	Lys	Asp	Ser	Ala	Leu	Leu	Arg	Ile	Glu	Ile	Glu	Met
1385						1390					1395			

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Ser Val 1415	Ala Lys Glu Lys Asp 1420	Asp Leu Gln Arg 1425	Leu Gln Glu Val
Leu Gln 1430	Ser Glu Ser Asp Gln 1435	Leu Lys Glu Asn 1440	Ile Lys Glu Ile
Val Ala 1445	Lys His Leu Glu Thr 1450	Glu Glu Glu Leu 1455	Lys Val Ala His
Cys Cys 1460	Leu Lys Glu Gln Glu 1465	Glu Thr Ile Asn 1470	Glu Leu Arg Val
Asn Leu 1475	Ser Glu Lys Glu Thr 1480	Glu Ile Ser Thr 1485	Ile Gln Lys Gln
Leu Glu 1490	Ala Ile Asn Asp Lys 1495	Leu Gln Asn Lys 1500	Ile Gln Glu Ile
Tyr Glu 1505	Lys Glu Glu Gln Leu 1510	Asn Ile Lys Gln 1515	Ile Ser Glu Val
Gln Glu 1520	Asn Val Asn Glu Leu 1525	Lys Gln Phe Lys 1530	Glu His Arg Lys
Ala Lys 1535	Asp Ser Ala Leu Gln 1540	Ser Ile Glu Ser 1545	Lys Met Leu Glu
Leu Thr 1550	Asn Arg Leu Gln Glu 1555	Ser Gln Glu Glu 1560	Ile Gln Ile Met
Ile Lys 1565	Glu Lys Glu Glu Met 1570	Lys Arg Val Gln 1575	Glu Ala Leu Gln
Ile Glu 1580	Arg Asp Gln Leu Lys 1585	Glu Asn Thr Lys 1590	Glu Ile Val Ala
Lys Met 1595	Lys Glu Ser Gln Glu 1600	Lys Glu Tyr Gln 1605	Phe Leu Lys Met

Thr	Ala	Val	Asn	Glu	Thr	Gln	Glu	Lys	Met	Cys	Glu	Ile	Glu	His
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1640						1645					1650			
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1655						1660					1665			
Val	Glu	Glu	Thr	Leu	Lys	Val	Glu	Arg	Asp	Gln	Leu	Lys	Glu	Asn
1670						1675					1680			
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1685						1690					1695			
Lys	Ile	Val	His	Met	His	Leu	Lys	Glu	His	Gln	Glu	Thr	Ile	Asp
1700						1705					1710			
Lys	Leu	Arg	Gly	Ile	Val	Ser	Glu	Lys	Thr	Asn	Glu	Ile	Ser	Asn
1715						1720					1725			
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1745						1750					1755			
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1775						1780					1785			
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1790						1795					1800			
Glu	His	Gln	Leu	Ile	Thr	Leu	Lys	Lys	Asp	Val	Asn	Glu	Thr	Gln
1805						1810					1815			

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1895						1900					1905			
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1925						1930					1935			
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Arg	Tyr	Ser	Glu	Met	Asp	Asp	His	Tyr	Glu	Cys	Leu	Asn	Arg	Leu
1985						1990					1995			
Ser	Leu	Asp	Leu	Glu	Lys	Glu	Ile	Glu	Phe	His	Arg	Ile	Met	Lys
2000						2005					2010			
Lys	Leu	Lys	Tyr	Val	Leu	Ser	Tyr	Val	Thr	Lys	Ile	Lys	Glu	Glu
2015						2020					2025			



Gln	His	Glu	Cys	Ile	Asn	Lys	Phe	Glu	Met	Asp	Phe	Ile	Asp	Glu
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Val	Glu	Lys	Gln	Lys	Glu	Leu	Leu	Ile	Lys	Ile	Gln	His	Leu	Gln
2045						2050					2055			
Gln	Asp	Cys	Asp	Val	Pro	Ser	Arg	Glu	Leu	Arg	Asp	Leu	Lys	Leu
2060						2065					2070			
Asn	Gln	Asn	Met	Asp	Leu	His	Ile	Glu	Glu	Ile	Leu	Lys	Asp	Phe
2075						2080					2085			
Ser	Glu	Ser	Glu	Phe	Pro	Ser	Ile	Lys	Thr	Glu	Phe	Gln	Gln	Val
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Leu	Ser	Asn	Arg	Lys	Glu	Met	Thr	Gln	Phe	Leu	Glu	Glu	Trp	Leu
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Asn	Thr	Arg	Phe	Asp	Ile	Glu	Lys	Leu	Lys	Asn	Gly	Ile	Gln	Lys
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Glu	Asn	Asp	Arg	Ile	Cys	Gln	Val	Asn	Asn	Phe	Phe	Asn	Asn	Arg
2135						2140					2145			
Ile	Ile	Ala	Ile	Met	Asn	Glu	Ser	Thr	Glu	Phe	Glu	Glu	Arg	Ser
2150						2155					2160			
Ala	Thr	Ile	Ser	Lys	Glu	Trp	Glu	Gln	Asp	Leu	Lys	Ser	Leu	Lys
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Glu	Lys	Asn	Glu	Lys	Leu	Phe	Lys	Asn	Tyr	Gln	Thr	Leu	Lys	Thr
2180						2185					2190			
Ser	Leu	Ala	Ser	Gly	Ala	Gln	Val	Asn	Pro	Thr	Thr	Gln	Asp	Asn
2195						2200					2205			
Lys	Asn	Pro	His	Val	Thr	Ser	Arg	Ala	Thr	Gln	Leu	Thr	Thr	Glu
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Ala Met	His Lys Glu Ser	Lys	Ile Ile Lys Met	Gln	Lys Glu Leu
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Glu Val	Thr Asn Asp Ile	Ile	Ala Lys Leu Gln	Ala	Lys Val His
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Glu Ser	Asn Lys Cys Leu	Glu	Lys Thr Lys Glu	Thr	Ile Gln Val
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Leu Gln	Asp Lys Val Ala	Leu	Gly Ala Lys Pro	Tyr	Lys Glu Glu
2285		2290		2295	
Ile Glu	Asp Leu Lys Met	Lys	Leu Val Lys Ile	Asp	Leu Glu Lys
2300		2305		2310	
Met Lys	Asn Ala Lys Glu	Phe	Glu Lys Glu Ile	Ser	Ala Thr Lys
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Ala Thr	Val Glu Tyr Gln	Lys	Glu Val Ile Arg	Leu	Leu Arg Glu
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Asn Leu	Arg Arg Ser Gln	Gln	Ala Gln Asp Thr	Ser	Val Ile Ser
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Glu His	Thr Asp Pro Gln	Pro	Ser Asn Lys Pro	Leu	Thr Cys Gly
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2375		2380		2385	
Ser Glu	His Ile Arg Leu	Glu	Lys Glu Ile Ser	Lys	Leu Lys Gln
2390		2395		2400	
Gln Asn	Glu Gln Leu Ile	Lys	Gln Lys Asn Glu	Leu	Leu Ser Asn
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Asn Gln	His Leu Ser Asn	Glu	Val Lys Thr Trp	Lys	Glu Arg Thr
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Leu Lys	Arg Glu Ala His	Lys	Gln Val Thr Cys	Glu	Asn Ser Pro
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Leu Pro Ser Pro His Pro Val Arg Tyr Phe Asp Asn Ser Ser Leu  
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Gly Leu Cys Pro Glu Val Gln Asn Ala Gly Ala Glu Ser Val Asp  
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1835						1840					1845			
Glu	Thr	Lys	Ala	Arg	Asp	Leu	Glu	Ile	Gln	Gln	Glu	Leu	Lys	Thr
1850						1855					1860			
Ala	Arg	Met	Leu	Ser	Lys	Glu	His	Lys	Glu	Thr	Val	Asp	Lys	Leu
1865						1870					1875			
Arg	Glu	Lys	Ile	Ser	Glu	Lys	Thr	Ile	Gln	Ile	Ser	Asp	Ile	Gln
1880						1885					1890			
Lys	Asp	Leu	Asp	Lys	Ser	Lys	Asp	Glu	Leu	Gln	Lys	Lys	Asp	Arg
1895						1900					1905			
Gln	Asn	His	Gln	Val	Lys	Pro	Glu	Lys	Arg	Leu	Leu	Ser	Asp	Gly
1910						1915					1920			



Gln Gln	His Leu Met Glu Ser	Leu Arg Glu Lys Cys	Ser Arg Ile
1925	1930	1935	
Lys Glu	Leu Leu Lys Arg Tyr	Ser Glu Met Asp Asp	His Tyr Glu
1940	1945	1950	
Cys Leu	Asn Arg Leu Ser Leu	Asp Leu Glu Lys Glu	Ile Glu Phe
1955	1960	1965	
His Arg	Ile Met Lys Lys Leu	Lys Tyr Val Leu Ser	Tyr Val Thr
1970	1975	1980	
Lys Ile	Lys Glu Glu Gln His	Glu Cys Ile Asn Lys	Phe Glu Met
1985	1990	1995	
Asp Phe	Ile Asp Glu Val Glu	Lys Gln Lys Glu Leu	Leu Ile Lys
2000	2005	2010	
Ile Gln	His Leu Gln Gln Asp	Cys Asp Val Pro Ser	Arg Glu Leu
2015	2020	2025	
Arg Asp	Leu Lys Leu Asn Gln	Asn Met Asp Leu His	Ile Glu Glu
2030	2035	2040	
Ile Leu	Lys Asp Phe Ser Glu	Ser Glu Phe Pro Ser	Ile Lys Thr
2045	2050	2055	
Glu Phe	Gln Gln Val Leu Ser	Asn Arg Lys Glu Met	Thr Gln Phe
2060	2065	2070	
Leu Glu	Glu Trp Leu Asn Thr	Arg Phe Asp Ile Glu	Lys Leu Lys
2075	2080	2085	
Asn Gly	Ile Gln Lys Glu Asn	Asp Arg Ile Cys Gln	Val Asn Asn
2090	2095	2100	
Phe Phe	Asn Asn Arg Ile Ile	Ala Ile Met Asn Glu	Ser Thr Glu
2105	2110	2115	
Phe Glu	Glu Arg Ser Ala Thr	Ile Ser Lys Glu Trp	Glu Gln Asp
2120	2125	2130	

Leu	Lys	Ser	Leu	Lys	Glu	Lys	Asn	Glu	Lys	Leu	Phe	Lys	Asn	Tyr
2135						2140					2145			
Gln	Thr	Leu	Lys	Thr	Ser	Leu	Ala	Ser	Gly	Ala	Gln	Val	Asn	Pro
2150						2155					2160			
Thr	Thr	Gln	Asp	Asn	Lys	Asn	Pro	His	Val	Thr	Ser	Arg	Ala	Thr
2165						2170					2175			
Gln	Leu	Thr	Thr	Glu	Lys	Ile	Arg	Glu	Leu	Glu	Asn	Ser	Leu	His
2180						2185					2190			
Glu	Ala	Lys	Glu	Ser	Ala	Met	His	Lys	Glu	Ser	Lys	Ile	Ile	Lys
2195						2200					2205			
Met	Gln	Lys	Glu	Leu	Glu	Val	Thr	Asn	Asp	Ile	Ile	Ala	Lys	Leu
2210						2215					2220			
Gln	Ala	Lys	Val	His	Glu	Ser	Asn	Lys	Cys	Leu	Glu	Lys	Thr	Lys
2225						2230					2235			
Glu	Thr	Ile	Gln	Val	Leu	Gln	Asp	Lys	Val	Ala	Leu	Gly	Ala	Lys
2240						2245					2250			
Pro	Tyr	Lys	Glu	Glu	Ile	Glu	Asp	Leu	Lys	Met	Lys	Leu	Val	Lys
2255						2260					2265			
Ile	Asp	Leu	Glu	Lys	Met	Lys	Asn	Ala	Lys	Glu	Phe	Glu	Lys	Glu
2270						2275					2280			
Ile	Ser	Ala	Thr	Lys	Ala	Thr	Val	Glu	Tyr	Gln	Lys	Glu	Val	Ile
2285						2290					2295			
Arg	Leu	Leu	Arg	Glu	Asn	Leu	Arg	Arg	Ser	Gln	Gln	Ala	Gln	Asp
2300						2305					2310			
Thr	Ser	Val	Ile	Ser	Glu	His	Thr	Asp	Pro	Gln	Pro	Ser	Asn	Lys
2315						2320					2325			
Pro	Leu	Thr	Cys	Gly	Gly	Gly	Ser	Gly	Ile	Val	Gln	Asn	Thr	Lys
2330						2335					2340			

Ala Leu Ile Leu Lys Ser Glu His Ile Arg Leu Glu Lys Glu Ile  
 2345 2350 2355

Ser Lys Leu Lys Gln Gln Asn Glu Gln Leu Ile Lys Gln Lys Asn  
 2360 2365 2370

Glu Leu Leu Ser Asn Asn Gln His Leu Ser Asn Glu Val Lys Thr  
 2375 2380 2385

Trp Lys Glu Arg Thr Leu Lys Arg Glu Ala His Lys Gln Val Thr  
 2390 2395 2400

Cys Glu Asn Ser Pro Lys Ser Pro Lys Val Thr Gly Thr Ala Ser  
 2405 2410 2415

Lys Lys Lys Gln Ile Thr Pro Ser Gln Cys Lys Glu Arg Asn Leu  
 2420 2425 2430

Gln Asp Pro Val Pro Lys Glu Ser Pro Lys Ser Cys Phe Phe Asp  
 2435 2440 2445

Ser Arg Ser Lys Ser Leu Pro Ser Pro His Pro Val Arg Tyr Phe  
 2450 2455 2460

Asp Asn Ser Ser Leu Gly Leu Cys Pro Glu Val Gln Asn Ala Gly  
 2465 2470 2475

Ala Glu Ser Val Asp Ser Gln Pro Gly Pro Trp His Ala Ser Ser  
 2480 2485 2490

Gly Lys Asp Val Pro Glu Cys Lys Thr Gln  
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120

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Asp Val Asn Met Ser His Lys Lys Ile Asn Glu Met Glu Gln Leu Lys  
 20 25 30

Lys Gln Phe Glu Pro Asn Tyr Leu Cys Lys Cys Glu Met Asp Asn Phe  
 35 40 45

Gln Leu Thr Lys Lys Leu His Glu Ser Leu Glu Glu Ile Arg Ile Val  
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Ala Lys Glu Arg Asp Glu Leu Arg Arg Ile Lys Glu Ser Leu Lys Met  
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Glu Arg Asp Gln Phe Ile Ala Thr Leu Arg Glu Met Ile Ala Arg  
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